TEXTILE RESEARCH

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TEXTILE RESEARCH

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In This Month's Issue

Boston Research Day

1944 Research Day in Boston salutes the textile industry. (See page 204.)

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Technological and Industrial Trends

It seems likely that the next twenty years will be characterized by the further breaking down of such barriers and boundaries as still exist between the present types of technology. (See page 208.)

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Training Textile Personnel

Colonel G. F. Doriot discusses the deficiencies in fundamental knowledge on the part of personnel in the textile industry and indicates the direction in which training should be taken. (See page 217.)

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Physiological Testing

The new method that is being employed by the Army in determining the utility of clothing to the wearer is discussed. The physiological method has been shown to be helpful in comparing garments with respect to comfort and protection and to the efficiency of the soldier. It has also been a means of suggesting changes in design of both garments and textiles. (See page 222).

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The Story of Coated Fabrics

The evolution of methods for the manufacture of coated fabrics has followed a sequence as the three main classes of raw materials became available, commencing with vegetable oils and leading to the modern synthetic resins. (See page 228).

Research Groups in Textile Industry Complete Organization of

Inter-Society Council for Textile Research

A constructive step toward the coordination of textile research activities, and the avoidance of unnecessary duplication, has been taken through the completion of the organization of the Inter-Society Council for Textile Research. It has just been announced that the voting representatives of the members of that Council have elected Giles E. Hopkins, director of applied research of the Textile Research Institute, Inc., chairman, with the following appointed members of the executive committee: John T. Wigington, director of the Division of Technical Service of the Cotton-Textile Institute, Simon Williams, director of research for the National Cotton Council of America, Wm. D. Appel, chief of the Textile Section of the National Bureau of Standards; and R. W. Vose, secretary of the Industrial Fiber Society.

Recognition of the need for just such an organization led to a meeting of representatives of the major textile research groups last fall, at which plans for the formation of the Council were laid. A steering committee was appointed and has now completed the organization.

It is planned that the Council will provide facilities for the maintenance of a continuous inventory of active research work sponsored by textile groups working in the interests of the industry. Through the use of this inventory, the individual organizations will be in a position to avoid unintentional duplication of studies already in progress. It is felt that this service should go a long way toward increasing the effectiveness of research for the textile industry.

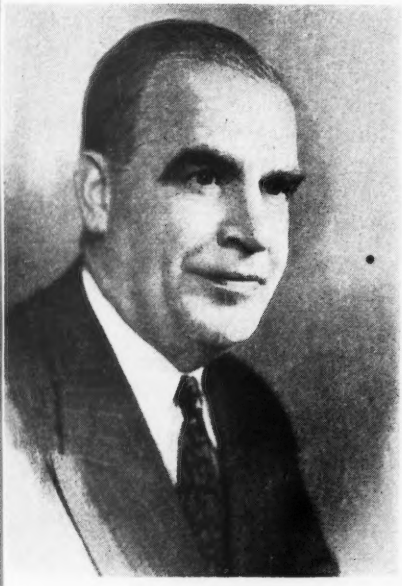
The organizations now cooperating in the Council are: American Association of Textile Chemists & Colorists; American Association of Textile Technologists; American Society for Testing Materials; Cotton-Textile Institute, Inc.; Industrial Fiber Society; Institute of Textile Technologists; National Bureau of Standards; National Cotton Council of America; Southern Regional Laboratory (Dept. of Agriculture); Textile Foundation; Textile Research Institute, Inc.; War Food Administration (Dept. of Agriculture).

Textile Research Institute Inc., Elects to Board of Directors,

Luther H. Hodges

Luther H. Hodges, vice-president of Marshall Field & Co., Inc., and general manager of its Manufacturing Division, has been elected a member of the board of directors of the Textile Research Institute, Inc., succeeding J. Spencer Love, who submitted his resignation when he became director of the Textile, Clothing and Leather Division of the War Production Board.

Mr. Hodges has also been elected a member of the executive committee of the Institute, in line with a recent decision to expand that Committee by the addition of not more than three new members.



Luther H. Hodges, newly elected director of Textile Research Institute, Inc., and appointed member of the Institute's Executive Committee.

Recognized in the industry for his independent thinking and forceful personality, Mr. Hodges has spent all his business life with Marshall Field. He served as office boy in the Carolina Cotton & Woolen Mills, Spray, N. C., owned by Marshall Field, in 1910 and 1911, between school years, and also during vacations while he attended the University of North Carolina. On graduation in 1919, he became secretary to L. W. Clark, then general manager, but also spent a good deal of his time working through the mill. He became production manager in 1935, and general manager in 1938. In 1940, he transferred his headquarters as general manager to New York and in 1943 was elected a vice-president of the company.

Mr. Hodges has always been interested particularly in employer-employee relations, and in the field of economic research. He is a member of the Committee on economic research of the Textile Research Institute, Inc.

Current Progress and Future Requirements in Textile Research were Outlined at

Boston Research Day

"That maker or user of man-made fibers will profit most who carries on and studies the results of research on natural fibers. We have yet to make a fiber with a fibril structure like that universally found in nature. How does nature do it? Conversely, the user of natural fibers must study the man-made fibers—if only to take advantage of their greater degree of uniformity and simplicity of structure as a means of simplifying the investigation."

The above statement was made by Professor Edward R. Schwartz at the seventh Annual Research Day held under the auspices of the Boston Chamber of Commerce, May 26, at Hotel Statler, Boston, Mass.

The program this year was devoted to the textile industry and its important contributions to the war program and to industrial progress and was opened with a luncheon attended by over 600 men and women. Guest speakers at the luncheon were the Hon. Sinclair Weeks, U. S. Senator from Massachusetts; and Colonel G. F. Doriot, Military Planning Division, Office of the Quartermaster General, Washington, D. C.

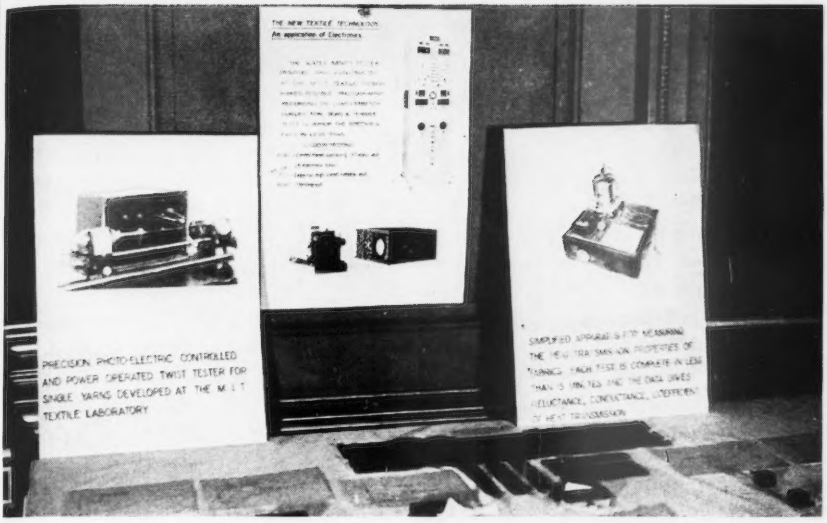
In his address "Research in Battle Dress," Colonel Doriot spoke of the progress accomplished in securing environmental protection for the soldier which is of particular importance because of the extremes of climatic conditions met in global warfare. The study of the effects of severe environmental stresses on the human machine, and the problem of adequately protecting the soldier so that he may meet these stresses without serious drain on his energy reserves, are problems of forces and materials, a fact which places them at once in the category of engineering—"human engineering" it may be called.

Live models exhibiting military clothing of today and yesterday were employed by Colonel Doriot to illustrate his discussion.

"Windproof and water-repellent clothes are still wide open to research and improvement," said Colonel Doriot. "Studies of the British-made Shirley cloth encourages the hope that for the first time in history we shall have a high grade fabric which when wet is waterproof."

• Textiles Today and Tomorrow

Following the luncheon a panel discussion, "Textiles Today and Tomorrow," was held under the chairmanship of Professor Edward R. Schwartz, head of the Textile Division, M.I.T. Wing Commander Peter Webb, Research and Development Branch, OQMG, placed emphasis upon the lack of knowledge at the start of this war of end-use requirements and the failure of laboratory tests to predict the performance of a given material.


THE NEW TEXTILE TECHNOLOGY
An application of Electronics
PRECISION PHOTO-ELECTRIC CONTROLLED AND POWER OPERATED TWIST TESTER FOR SINGLE YARNS DEVELOPED AT THE M. I. T. TEXTILE LABORATORY

Part of an exhibit by the M. I. T. Textile Division showing standard methods of test and several new developments in textile technology in which electronics play an important part.

"The Quartermaster has now sent his observers to all corners of the world and trained them to measure quantitatively the failure of an article and to define the precise performance characteristics required," the speaker stated. "There is a gap, however, between the field requirements and their interpretation in the physical terms with which industry is accustomed to deal. In many instances this gap occurs because of the limitations of the measuring devices or method used in the laboratory. For example, it is possible to measure the shrinkage of a woolen sock, but the pressure exerted by a shrunk sock on the foot has not been measured; and this, in terms of the function of the sock, is much more meaningful to the Quartermaster. As a further illustration, consider the requirements for a fabric which will be impenetrable to mosquito bites. By tedious trial and error proving, a good fabric can be selected from a poor fabric, but I do not think that anybody knows whether such a characteristic may be represented in terms of the complexity of the texture, or the smoothness of its surface, or evaluated in terms of such conventional units as air permeability, light transmission, or thickness: such an evaluation would save much research and development time.

"Possibly we have all been delinquent in the past by failing to have interest in the purpose for which a fiber or fabric is intended. I hope that research in the postwar years will scientifically proceed to measure in absolute values the behavior desired by the farmer in long-wearing denims, the telephone linesman in his flexible and warm gloves, and the fisherman in his waterproof footgear. Such an analysis becomes possible if the indus-

try cares to support trained teams of observers, and to establish controlled field proving grounds in schools, CCC units, or even jails, where accelerated testing may be devised to simulate consumer use. Only after that time, and especially where life is at stake, should we feel confident in selecting our textiles upon their purely physical characteristics as determined in the laboratory."

Current Trends in Research

Another speaker, Giles E. Hopkins, director of applied research, Textile Research Institute, Inc., in discussing current trends in applied research, stated, "There are two definite points to be made in interpreting these trends,

"First, the next few years will produce a more complete understanding of the functional requirements of textile products and greatly augmented data on the peculiar characteristics of each of our major raw materials. Instead of thinking in terms of fabric constructions we will turn our attention to measurable performance. Instead of discussing wool fiber, cotton fiber, or viscose we will think in terms of inherent fiber characteristics such as tensile strength, resilience, chemical activity and heat resistance.

"Second, our interests will include a broader scope of ideas and a more comprehensive view of the industry. Gadgeteering will continue, but there will be a parallel and well-supported effort which may result in radical changes in textile processing.

"Surveys of functional performance which have been forced upon us by war conditions show that many of our assumed relationships between construction and performance were fallacious. Techniques have been developed for measuring the physiological reactions to various textile products and for interpreting these data in terms of product characteristics. Data on comparative sweat rates of men working under jungle conditions, wearing various of our standard fabrics, have been correlated with construction characteristics of thinness, weight and porosity. This has given us new construction standards to shoot for.

"Studies on the warmth or insulation value of various fabrics have indicated that it may be calculated directly from thickness and resilience, both measurable characteristics, thus putting quantitative values in place of the traditional qualitative assumption that 'wool is warmer than cotton.' This same technique, applied to hundreds of other textile uses, will give us a conception of the utility of textile products which, because it is definite and expressed in measurable values, will open an almost unlimited field in product improvement.

"Fundamental research on the characteristics of the fibers themselves and the relationship between these characteristics and those of the required products will open the door to many new ideas on the selection of raw materials for particular purposes.

"With this improved knowledge of the functional use of the end product and the peculiar characteristics of each of the fibers, the methods of fabrication may then be worked out with the minimum influence of traditional processes.

"Events over the past five years have placed the spinning and weaving processes definitely on the defensive. The carded cotton web, in which thermoplastic fibers are interlaced and then bonded to each other, forming porous continuous sheet material, is

one demonstration of a technique providing the simplest possible conversion of the fibers to usable products.

"Science and engineering have provided us with numberless new techniques which may be fashioned into tools for the industry. If the textile industry allows these tools to lie idle or does not have the imagination to adapt them to its advantage other industries will do so, and larger sections of the textile market will be captured.

"The application of these tools is definitely within the scope of applied research. As you will see, it includes a broad concept of the industry and may result in radical changes in it. Work will, of course, be continued toward improved loom capacity, increased spinning efficiencies, new constructions in woven goods; but work which will result in the more basic changes I have just outlined will also proceed at a rapid pace.

"The techniques are available. In a few cases they have been already recognized and put to use. Those industries which are now providing the greatest competition to the textile industry—the chemical industry, the paper industry, and the plastics industry—owe their existence to the recognition and use of just such principles. It is, therefore, inevitable that the present and future trends in applied textile research must show the same imagination and the same degree of initiative."

Fig. 2. Part of exhibit by Gustavus J. Esselen, Inc. Illustrated are some 3-dimensional photomicrographs.

Research Exhibits

A feature of the occasion was the extensive array of exhibits provided by research organizations and educational institutions in the textile field. Among the exhibits were: an exhibit of clothing and equipment provided by the Office of the Quartermaster General; exhibits and photographic presentation of various types of textile testing methods, provided by the Textile Division, M.I.T.; various stages of the production of fabrics from wool and redwood-bark fibers, provided by the Fabric Research Laboratories in cooperation with the Pacific Coast Lumber Company and Lowell Textile Institute; enlarged photomicrographs of surfaces and interior cross-sections of so-called fused collars, also a showing of 3-dimensional photomicrographs, by Gustavus J. Esselen, Inc.; examples of textile uses for glass fibers including a glass fiber of one micron diameter (1/25,000 inch), by Owens-Corning Glass Corporation; and an exhibit in connection with research on the development of special fabrics and processes, by the Lowell Textile Institute.

A Forecast of the Future Requires Projection of Both Past and Continuing

Technological and Industrial Trends

II—The Next Twenty Years

By ROLAND P. SOULE

This is the second of two articles which present an abstract of an address by Dr. Roland P. Soule, delivered before the January meeting of the Industrial Research Institute. In the first article, which appeared in the previous issue of TEXTILE RESEARCH, *Dr. Soule outlined changes which have been taking place in research and technology and discussed the impact of these changes on corporate profits and corporate policies. A simile was drawn between the life cycle of a typical industrial product and that of a human being: "Corporate profits can no more be perpetuated without new products than family names can be perpetuated without new children."*

Reprints of these two articles bound in pamphlet form will be available on request from Textile Research Institute, Inc., 10 East 40th St., New York 16, N. Y.

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The imprint of the chemical engineer and the metallurgist upon the history of the last twenty years is quite clear. Applied physics—electrical and mechanical engineering—continued to grow, but it was outrun by applied chemistry. Industry became increasingly more interested in the materials of construction than in their tools and methods of fabrication. It concentrated more on molecules and less on mechanics.

But what about the next twenty years? Are we still in the era of the chemical engineer? An examination of the principal trends of the recent past indicates "no" as the best answer to this question. It is a qualified "no," however, because industrial chemistry still has before it the period of its greatest growth. Nevertheless, it seems safe to forecast that the period from 1940 to 1960 will not be characterized by the ascendancy of any single branch of technology, whether of the old conventional type or of some new type such as "electronic engineering." Instead, it seems much more likely to be characterized by the further breaking down of such barriers and boundaries as still exist between the present types of technology.

This conclusion is not spectacular and may even be regarded as disappointingly vague. But let me illustrate what I mean. Chemistry and physics were once considered separate sciences, but what would be the industrial status today of ammonia and other products of high pressure synthesis if chemistry hadn't learned from physics the principle of the phase rule

and other laws of thermodynamics? And this re-wedding of the sciences has only just begun. Architecture, which was once part of civil engineering, will take on a new vigor only when it turns first to the chemical engineer for new materials of construction and then back to the civil engineer for the new principles of construction which the new materials will require. Prefabricated housing—when and if it comes—will result only from the closer and more intimate collaboration of many arts.

The next generation of chief engineers hired by manufacturing companies will have to know more than one branch of engineering. Consider, for example, an operation we may characterize as typical of the future: the molding of some new composition of fiber and plastics. The selection of the proper raw materials—what fiber? and what plastics?—will require chemical engineering. The development of an electronic system of heating to cure the plastic will require electrical engineering. And finally, the design of the complete apparatus, to meet the specifications for continuous, automatic operation on a tonnage basis, will require mechanical engineering.

Thus, manufacturers in one art are going to reach out farther and farther into the arts of others—a trend already noted in connection with the changing aims of research. They are going to become familiar with new materials, new manufacturing methods, and new products. From an industrial research standpoint, therefore, the outstanding characteristic of the next twenty years will probably not be the further advance of the already more advanced industries. Such industries will continue to grow, of course, but they seem unlikely to raise their heads still higher above the rest. On the contrary, the most significant feature of this next period is much more likely to be the coming up from behind of some of the now more backward industries and arts.

Changing Technological Position of Producer and Consumer

Another current in the mainstream of technological change relates to the changing position, technologically speaking, of the consumer relative to the producer. Research in the future is going to work more for the consumer and less for the producer. Recall, if you will, that research to date has been pretty much in the hands of the big companies and that the big companies have been mostly the primary producers and refiners of materials of all sorts. The objective of such research has been to force a maximum of nickel, of aluminum, of copper, of gypsum, of asbestos, of plastics, etc., into as many different markets as possible. It is a technology of adaptation, and its success has been measured by the tonnage of materials sold by the companies financing that research.

It does not require much imagination to realize, however, that only through coincidence would the products resulting from such research happen also to be the most suitable for the purpose in question. How many of you will admit, for example, that the best roofing, the best wallboard, and the best flooring that we can buy today are really the best that can be designed? Suppose, for example, that you were not committed to use some one material in large part but had com-

plete freedom to select, in type or quantity, any material or combination of materials that best fitted your purpose. Then, isn't it reasonable to believe that you could produce something representing a better compromise of cost and performance than the best now offered on the market today?

It seems safe to predict, therefore, that in the future a smaller proportion of the country's total research effort will be upon adaptation—the forcing of a given material into a given market whether it has an inherent right to be there or not. There is reason to believe, on the other hand, that more attention will be paid to a new type of technology. Such technology takes the customer's point of view, and can best be described as functional engineering. Research of this type is most willingly financed by companies that own no mines or quarries, that have little or no stake in specific commodities, and that hence can be more objective in their choice of materials.

Functional engineering is almost always characterized by an increased emphasis upon the principle of composite construction. When it is practiced more widely, we shall see many fewer products made largely of metal, wood, paper, textiles, plastics, or of any single material alone. We shall see, in their place, many more articles representing combinations of such materials, in which each material serves best its own particular function in a way that lowers the net cost of the final product at no sacrifice of quality. In short, we shall witness some important industrial weddings such as textiles and plastics, fibers and plastics, and plywood and stainless steel. And it is from combinations of this type that backward industries, such as textiles and building materials, will derive the chief impetus for their future development.

Vertical Integration and the Fabricator

In a country such as ours, where wage rates are already high and seem only to move higher, one of the most fruitful methods of reducing the net cost of anything has been to economize on materials. The anticipated greater emphasis in the future upon both functional engineering and the principle of composite construction is, therefore, only the further projection of a technological trend which has long been in evidence. This trend has been increasingly apparent for many years in improved design, less waste in manufacture, greater recovery of scrap materials, and the better protection of finished products against rust, fire, decay, and mechanical wear. Durable goods are becoming more durable, and non-durable goods less so. Consequently, every time the Federal Reserve Board index returns to a given level of production, we find that fewer tons of materials of all sorts are required to support that level.

As a direct result of this development, a new trend of research significance has been set in motion. It is the final trend I wish to touch upon, and it concerns the impending shift in the balance of industrial power away from the primary producer and in the direction of the fabricator.

By the "primary" producer I mean the producer of primary materials of construction—steel, copper, aluminum, lumber, cement, glass, chemicals, paper, etc. And by "fabrication" I mean the art of converting these primary mate-

rials into semi-manufactured or completely manufactured products.

In the early days of American industry the disparity between the unit size of the primary producer and that of the fabricator was at its maximum. The ironmaster, for example, sold directly to the blacksmiths, the lumberman to the carpenter, and the textile mill to the dressmaker. Then, with the passing of time and the growing complexity of manufacturing operations, the fabricators grew larger in their corporate size and importance. They now include a few companies of even the magnitude of General Motors and General Electric. But by and large, the primary producers, as typified by U. S. Steel, Kennecott Copper, International Nickel, the Aluminum Company, Allied Chemical, International Paper and a host of other companies, still dominate any list of the biggest and most important industrial enterprises.

If the present war has done nothing else, it has greatly increased the installed capacity of this broad group of primary producers. Of course, if the normal level of business after the war is to be measured by 150 or more on the Federal Reserve Board index, they need have no serious worries over their immediate future. But for the longer term they now stand confronted by two seriously adverse trends: first, a continuing increase in the number and general availability of competing materials of all kinds; and secondly, a continuing increase in the economy and general efficiency with which industry is fabricating those materials.

In our new world of accelerating technological change, therefore, we must re-appraise old values. We must place considerably less stress, for example, on the old virtue of vertical integration and considerably more stress on the new virtue of flexibility.

Consider, for purposes of illustration, the relative position of U. S. Steel and General Motors. U. S. Steel is a vast industrial empire, controlling its own cargo boats and railroads, its own blast furnaces, open hearths, rolling mills and fabricating facilities. So long as its principal objective continues to be the manufacture of huge tonnages of cheap steel and its primary products, the company will continue to justify the expectations of its founders. But because of both the growth of competing materials and the general trend toward increased economy of utilization, a continued shrinkage in the tonnage of steel consumed per unit of the Federal Reserve Board seems almost inevitable.

We are gradually accumulating in this country many such industrial "Maginot lines" or enterprises which are invulnerable only if attacked from the anticipated direction. They are far from invulnerable, however, to the forces of technological obsolescence, which rarely make a frontal attack but which usually simply circle around their opposition. Under such circumstances the original advantage of entrenched strength has a way of winding up as something of a disadvantage —the handicap of an almost crippling degree of immobility.

General Motors, on the other hand, well illustrates the increasing value of industrial flexibility. It long since has disposed of the commitments in standing timber which made it so slow in adopting the all-steel body. It also long since sold its safety glass plant to Libbey-Owens-Ford, and now is free to replace safety glass by plastics or

any more suitable product that may come along. In fact, it is free to use aluminum or steel for its bodies, natural or synthetic rubber for its tires, magnesium or zinc for its die-castings, nitrocellulose or alkyd resins for its lacquers, or any one of the lengthening parade of interesting new materials for any purpose it chooses. The fabricator can build his business on the sound foundation of established and continuing markets, while the producer of materials must contend more directly with the shifting sands of technological change.

Economics of Fabrication

An increasing industrial interest is to be expected in the art of fabrication for several reasons. First, existing fabricators are almost certain to continue to reach out into neighboring fields and broaden their own product structure. Industrial "Fence-hopping" is very much the order of the day. In the building material industry, for example, the asphalt roofers have invaded the gypsum business, the gypsum companies have invaded the roofing business, and both the roofers and the gypsum companies have invaded the fiber wallboard business.

Likewise, producers of some raw materials are going to carry the fabrication of their product closer to the ultimate consumer. They are going to get weary trying to persuade existing fabricators to do the job they think ought to be done with their materials, and they are going to do it themselves. They are going to steal a march on those not yet awake to the fact that the time-worn slogan "Don't compete with your own customers" may no longer be a sound business policy in every situation. Too often, in fact, it has become only a weak substitute for farsighted and quantitative thinking. The real test of the wisdom of such competition in any given case lies, of course, in the answer to the question: "Will the new earnings won be greater than the old earnings lost?"

But what about the fabrication of the composite products I have mentioned—such as mixtures of plastics and textiles or of plastics and paper? Everybody knows that the molding of plastics, for example, has not in general been a very profitable industry in the past. Why should it be in the future? The answer lies chiefly in what the economist calls the "value added by manufacture." When this value is low as at present, raw materials represent a large percentage of the total cost, and the molder's chief hope for bettering his slender margin of profit has lain in making a maximum of his own materials. But to the extent that the art now follows its inevitable trend toward greater technical complexity and a larger capital investment, both the value added by the manufacture and the opportunity for a satisfactory, single-operation manufacturing profit will increase in direct proportion.

Producers of primary materials have expressed two further objections to entering the business of fabrication. One relates to merchandising. "We don't know how to sell to the consuming public," they say, "and we have no facilities for that type of distribution." Here again a clue to the future may be found in the same new trend. As a result of the increasing technological complexity of fabricated products, important intermediate manufacturing operations are appearing between those of the primary producer and those of the ultimate maker of the final article

sold at retail. Thus, the initial fabricator may not have to merchandise to the public. For example, he may sell his combination of plastics and textiles to the shoe manufacturer and his mixture of plastics and paper to the bag maker.

The other objection relates to raw materials. The plastic maker may say "Too much of this product comes from textiles." And the textile maker may say "Too much of this product comes from plastics." Hence, neither company takes action, and as a result the stork still holds in his custody today many potentially brilliant new products that are awaiting one of those industrial weddings I have already mentioned. And it can be a wedding of corporations as well as of materials. As the industrial opportunities multiply which cannot be seized by any one company alone, we shall probably witness the increasingly frequent organization of jointly-owned subsidiaries.

My final observation on the economics of fabrication is concerned more particularly with the chemical industry. Most investment analysts are optimistic over its prospects for long-term growth, particularly in the organic field. The carbon compounds not only have proved themselves the most versatile and the most adaptable to the manufacture of new industrial products, but they also have benefited the most from the continued development of such low-cost, large-volume raw materials as petroleum, natural gas, cotton linters, woodpulp, and soy-bean oil. Let it be noted, however, that the organic chemical manufacturers as a group are unlikely to have the same relationship to their raw materials in the future as they may have had in the past. They are going to be increasingly crowded, for example, by the oil companies themselves, who are the logical manufacturers of compounds such as ethyl alcohol, styrene, and a whole new group of similar "intermediates" derived from cracking still gas. Many chemical companies will be well advised, therefore, to avoid combat with an inherently adverse trend, and to devote their special talents more to the real bottleneck in the path of tonnage markets—namely the more effective combination of their products with other materials.

Management and Diversification

In conclusion, it should be pointed out that technology, which made many large industrial companies grow to their present size, is now operating to keep them from growing very much larger. Working both directly and indirectly, it is setting a fairly definite limit to the extent by which the big can continue to grow at the expense of the small. Part of the reason, as already mentioned, is the tendency of the big companies—particularly those with heavy, commitments in specific raw materials—to become muscle-bound and inflexible. But another and perhaps more important reason is the tendency of the managements of large companies to become over-cautious and sterile.

We are all familiar with that most characteristic phenomenon of big business today—the divorcement of ownership and management. It has set up a new and different sort of management incentive, in which salaries usually bulk larger than dividends. I do not say that management today is not conscientious according to its own

standards, but I do say that standards themselves are often too shortsighted. Modern management regards itself as a trustee for its stockholders, but the psychology of the trustee is primarily to conserve and to protect, and not to take risks except as a last resort. It has become the instinct of too many corporation officers to let well enough alone and to become overly complacent. They thus blind themselves to the fact that, in industry as in war, the only sure defense is attack. They fail to realize that industrial corporations, like Alice in "Through the Looking Glass" must run faster and faster if only to stay in the same place. Paradoxically, the only really conservative executive attitude today is a deliberate policy of intelligent risk-taking.

But such weakness on the part of the big companies creates, of course, a corresponding opportunity for the smaller ones. Technology, as the fundamental source of change in industry, is the force that prevents any distribution of corporate strength from remaining long the same. It is the slingshot by which the Davids of the future will bring down some of the Goliaths of today. Hence, if already established businesses are to escape the adverse effects of accelerating technological change, their managements must place more and more emphasis upon the principle of diversification. No product of any company is immune to competition—competition either from similar products made by new and cheaper methods, or from quite dissimilar products serving the same purpose but in a better fashion. The profits from any single product will inevitably reach a maximum and then run down like a clock. And only one effective answer is possible. As I have repeatedly emphasized in this talk, it is the continuous recruiting of new products to replace the casualties among the old.

This simple truth is reflected in the stock market, which recognizes sharp distinction in the probable durability of corporate profits. Let me conclude by pointing out that the companies which sell the highest in relation to their current rate of profits are all characterized by a broad diversification of business. Contrast, for example, the typical price-earnings ratios of General Electric and Master Electric, of U. S. Gypsum and Masonite, and of Allied Chemical and Westvaco Chlorine. It is not a record of recent growth in profits from a relatively few products which the investor has learned to value the most highly. It is rather the old idea of "safety in numbers" and the insurance which it gives against the unpredictable but ever-mounting risks to be faced from the technology of tomorrow.

Like the investor, therefore, the research director will do well to recognize that corporate profits have two dimensions: not height alone, but area of base as well. This principle, as stated in these simple architectural terms, has been amply confirmed by the experience of the ages. Thus, all the obelisks of ancient Egypt have long since fallen, but every pyramid still stands.

RESEARCH ACTIVITIES

Fuller E. Callaway, Jr., president of Callaway Mills, La Grange, Ga., speaking extemporaneously before the annual meeting of the Cotton Manufacturers Association of Georgia, held at Atlanta, stated that while rayon yarn producers spend 3 to 4% of each sales dollar for research, textile manufacturers spend practically nothing. He added that in the past the textile mills had an excuse for not spending any money since there was no organized research available, but that this excuse no longer exists since there are now three splendid research organizations, namely, Textile Research Institute, Inc., Institute of Textile Technology, and the Callaway Institute, Inc. He added that every textile manufacturer should line up and support one or more of these agencies.

The appointment of a committee of the National Council of Textile School Deans to cooperate with those officials of the Veterans Administration charged with direction of the educational features of the rehabilitation program has been announced by E. W. Camp, dean of the Department of Textile Engineering of the Alabama Polytechnic Institute, Auburn, Alabama, who was elected president of the Council at their recent spring meeting in Asheville, North Carolina. The committee consists of Charles H. Eames, chairman, president of Lowell Textile Institute; W. D. Fales, head of the Textile School, Rhode Island School of Design; Malcolm E. Campbell, dean, North Carolina State College Textile School; and Richard S. Cox, dean, Philadelphia Textile Institute. As a result of a conference with government officials just concluded in Washington, an introductory statement was prepared and is now being distributed to the fifty regional offices of the Veterans Administration so that advisors in those offices may have available more precise information about opportunities for employment in the textile industries and about training facilities available in the textile schools. A second eight page pamphlet is now in preparation by the National Council's educational committee and it will include more detailed and technical information about courses available to students who wish to prepare themselves for specific jobs in the textile industries. An attempt will be made to include in this second statement definitions of jobs and courses. Copies of the first introductory statement may be obtained at the publication office of the Textile Foundation at Kent, Connecticut.

Wool textile research on a large scale is being considered in Australia, according to a recent announcement. Plans which have been submitted to the Federal authorities in that country propose the establishment of a research institute and provide for intensification of pastoral and wool textile research and other objectives on an unprecedented scale. The initial cost of the institute and equipment is estimated to be more than £500,000 and thereafter annual costs might exceed

£200,000. This latest development follows renewed discussions on the possible threat to the wool industry from synthetic fibers.

A new department of research has been established by S. Stroock & Co., Inc., woolen manufacturers. Dr. A. C. Whitford, well known fiber technologist, will be in charge of the department and will occupy a newly completed laboratory adjacent to the company's mills in Newburgh, N. Y. Research will be conducted on the structural properties and potentialities of all the natural fibers, according to a recent announcement. Special attention will be directed toward the development of new textures and finishes in fabrics made of the rare fleeces and hairs of the vicuna, llama, alpaca, camel, kashmir, and angora goats, in the processing of which the Stroock Company have specialized for the past fifty years.

Application of sound waves to the accurate measurement of elasticity of yarns and fibers has been announced by Du Pont. The velocity of sound through any medium, whether it be air, water, rayon, nylon, cellophane, or steel, is determined by two properties of the medium, its density and its modulus of elasticity, therefore, it is necessary only to find out how fast sound passes through the test material (the density of which is already known) to calculate its elastic modulus. The Rayon Technical Division apparatus is set up to measure the velocity of sound through the fiber or film. The method, according to Drs. Ballou and Silverman who conducted the experiments, applies a small force to stretch the material rapidly enough to avoid plastic deformation. It gives elastic modulus values two or three times those obtained with the slow loading or static method and more closely reproduces the type of strain which will be imposed on many materials in actual use, such as the fabric and the rubber going into tires. Here the load is applied very rapidly to any one part of the tire, as it revolves along the road at high speed. The set-up is so simple that it can be placed in a closed chamber for measurement of the modulus under a wide range of temperatures and humidity.

The appointment of Harold Brayman to be director of the public relations department was announced by E. I. du Pont de Nemours and Co. He succeeds the late Theodore G. Joslin, who died suddenly April 12.

A synthetic resin coating for waterproofing fabrics being made by Pratt & Lambert, Inc., paint and varnish manufacturers, for treating fabrics to be cut up for raincoats for the Army, will be introduced to the fabrics trade after the war for civilian use, according to Harold E. Webster, president. "Fabrics coated with this synthetic resin are absolutely waterproof. They will withstand a temperature of 40 degrees below zero and abnormally high temperatures. The fabric will not crack or become sticky so that it will be an ideal coating for men's and women's rainwear. It also can be applied to cotton duck for tents and awnings and being made in various colors, it can be applied to upholstery fabrics for furniture manufacturers and drapery fabrics."

Army's Experience in War-Time Research Reveals Need of Specialization in

Training Textile Personnel

The following extract from a paper prepared by Colonel G. F. Doriot of the office of the Quartermaster General, and presented in his absence by Lt. Col. D. B. Dill before the American Philosophical Society in Philadelphia, highlights a need often emphasized in these columns: that for a new approach to the training and encouragement of technical personnel in the textile industry.

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We have learned many lessons from this war but I think the outstanding lesson is the absence of an almost elementary technical knowledge among the majority of personnel engaged in certain industries whether during war or peace. Loose thinking predominates the claims made for certain raw and converted materials; but a little study of and thorough acquaintance with a few subjects is the type of knowledge which is really useful. There is a wide gap between research workers and those who should normally be called upon to apply the results of research. As a consequence, certain industries ignore what science has to offer.

I would like to discuss an anomaly in our education picture. When a student graduates as a lawyer, a doctor or an engineer, he becomes a professional man. He deserves the rank he then attains, for he has studied and he has become adept in a specialized field. The backlog of knowledge arising from such concentrated study prepares him for all variables of his future professional life; it makes him receptive to innovations and it gives him the spirit to meet a particular situation with the background of at least theoretical training. Other professional men in many industries are entitled to the same recognition and get it.

I do not think many of those associated with the textile and clothing industries have been educated with the same intensity. I count among my very close friends leaders in textile and leather technology, mill-men, and clothing designers who have performed wonders for the soldier. On the other hand when I raise a certain question, discuss a radical approach, I get the reply that there is no answer to that particular problem and that a fundamental research study will have to be initiated.

In textiles, while the synthetic industry has approached its problems in a highly scientific manner, the individuals in that industry, with very few exceptions, do not have the background of fundamental knowledge

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Abstract of a paper read at the annual general meeting of the American Philosophical Society, April 20, 1944, in a Symposium on Wartime Advances in Medicine. The papers of this symposium will appear in Volume 88, No. 3 of the Proceedings and copies may be purchased from the Society, Independence Square, Philadelphia 6, Pa.

which could have saved all of us many months of searching, and the duplication of one another's efforts. The achievements of other industries or of other sections of the same industry have not been known and obvious solutions have been ignored. I wonder if those concerned with raw textile components of fiber and cloth are as conversant as they should be with the converted product and its purpose.

Specialized Training Necessary

I suggest that the textile and clothing industries encourage young men to embark early upon a career of training, and most important, to specialize in a particular phase, whether it be yarn, dyeing, clothing design, zippers, collars or looms; that the training be with the aim of pursuing their trade with the same diligence as the lawyer pursues his; that we come to realize that the textile and clothing industries do not provide occupations to and from which one may drift and yet expect to be successful or contribute much to the welfare of others; that the clothing industry should be looked upon as having an unlimited scope ahead of it in designing, and using that functional design, if you like, as a merchandising weapon—with the material and cut adapted to the wearer's particular task. I do not believe, and I hope you agree with me, that we can possibly create a nucleus of qualified personnel unless we take advantage of scientific study, research, development and testing.

Let me illustrate a point where with sufficient curiosity, the textile and clothing trade would have called science to its aid with probable advantage. How many times have we heard the expression: "Everybody knows that you can't wear impermeable clothing?" The word porous is often used with very little further thought as to what kind of impermeability we are so loosely discussing.

If you care to picture the mud and cold wet conditions of modern warfare, you would be more inclined to reword that common claim to "Everybody knows that you can't wear impermeable clothing with comfort but at least you may be a little more comfortable than being wet through in permeable types of clothing."

If you stop to analyze the discomfort of impermeable clothing, that is, textiles which are impermeable to free water and water vapor, that discomfort will be found to be primarily associated with body cooling. Allegedly, the body suffers when the escape of water is prevented, but I do not believe proof exists, at least in temperate climates.

Science, on the other hand, could have discovered the effect of not wearing impermeable clothing in cold, wet conditions; it might have found that if a quart of water or rain enters the clothing from outside, 15 kg calories are required to raise the temperature of water at 41 degrees F., to 68 degrees F.; this heat so wasted on heating the water is equivalent to one fifth of the heat produced in an hour by a resting man. This is a wasteage of 20%. This however is but a small wastage; as soon as the absorbed water in the clothing becomes warmer than air, it begins to evaporate. To evaporate that quart of water requires about 500 calories which is over six times the heat produced by a soldier during an hour's rest.

Thus it may be understood that vapor permeable clothing stacks up a large heat debt when wet; clothing which is perfectly adequate at zero

when dry, will be hopelessly inadequate when wet at plus 50 degrees F., if worn for but a short length of time.

If science had pursued this investigation further, it would have found that the reasons for the discomfort of vapor impermeable clothing—your common waterproof garments—is that normal clothing underneath it becomes slowly wet through by perspiration and that there is insufficient air movement to vaporize this moisture and to carry it off. Eventually when the impermeable clothing is removed or when air movement increases there is evaporation and cooling. Moreover, the thermal conductivity of water is high compared to air, so that the insulating properties of air-laden textiles are lost and they become more or less a thin plastic mass under such conditions.

With all these facts before it, textile and clothing research workers might have considered that a scientific adaptation of the good points of impermeable and permeable clothing would be made; they might have found that a vapor barrier near to the heat source, i.e., the body, and another on the outside of the garment between which could be sandwiched a permeable thermal insulating layer, would achieve the desired end. By placing one vapor barrier near to the heat source, the vapor pressure thereat would be somewhere near to that at the skin with a consequent slight gradient such that evaporative cooling would be reduced tremendously. Air movement would be practically non-existent between the impermeable barriers.

It Isn't Necessarily So

There are many army tasks which do not call for high activity and high sweat production. I don't know if vapor impermeable clothing can be used, but we have certainly been wrong in arbitrarily saying it cannot.

Our technologists in textile matters have inclined to the thought that tensile strength and tear strength predicate the ultimate durability, comfort or the usefulness of a textile or garment. The Army has had the opportunity of setting up field tests with a large number of samples and from it ascertained a certain pattern of wear which is associated with some other physical property but doubtfully represented by tensile and tear strength. It has been the Army's fortune to show that the physical tests on which the industry has placed its confidence for years and years are probably unreliable and certainly not representative. With vision and a little more realism, I am sure that the industry could profitably have diverted its powerful scientific ability to analyzing the durability, functional characteristics and performance required by the consumer and, thereafter, it could have devised the physical tests which duplicated the actual conditions.

I feel sure that the rather bitter lessons learned by the Army will be valuable to industry after this war. I would like to close this address by urging this society to foster facilities for thorough technological together with liberal training so that the quest for knowledge by the humble loom fixer, spinner or seamstress may be satisfied. From these trained young men and women—given opportunities for advanced professional education and research experience—will come leaders in the clothing and textile industries. These professional experts, call them textile engineers, will provide the Quartermaster with facts rather than opinion as a background for action if and when another war comes.

RESEARCH AIDS

Adhesives

A new catalog section on its line of adhesives or cements has just been published by The B. F. Goodrich Company, Akron, Ohio, and is now available upon request. In addition to the field of adhesives, the materials covered in the volume serve as fabric coatings, binders, sealers, etc.

The catalog section discusses the service requirements and classification of the various adhesives, and then lists and discusses each type offered. Instructions on application and data on the company's standard containers are included, with approximate shipping weights.

Many of these cements are, at the present time, sold only under the rubber restriction order so can only be used for permissible purposes.

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Laboratory Equipment*

Whether a new laboratory building is planned or an old one is to be refurnished; or whether the project is large or small, there are certain fundamental rules on laboratory planning that should be observed. These rules relate to room coordination, room size, location of the various pieces of laboratory equipment with relation to one another and with relation to doors, windows, pipe shafts, etc.

The Laboratory Furniture Company offers a free engineering service extending the benefits of its study of numerous, well planned, practical, and economical installations, and the experience gained through more than 10,000 laboratory installations completed, including such important installations as Regional Laboratories of the U. S. Department of Agriculture, Squibb Research Institute, and Stamford Research Laboratories of the American Cyanamid Company.

The company's latest 224 page catalogue also illustrates and describes its complete line of laboratory and special equipment, including many items of out-of-the-ordinary equipment designed for specific needs.

* The Laboratory Furniture Company, Long Island City, New York.

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New Testing Price List

The specific test charges by U. S. Testing Co., Hoboken, N. J. for textiles, chemicals, metals, foods, and numerous other materials are listed in a new booklet just issued by that company. The Testing Company published its first general price list many years ago and the many subsequent revisions speak well of the usefulness of such price lists. This new testing price list presents, in a compact form, the broadening in scope of the Testing Company's work in recent years.

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Electrolytic Conductivity Measurements

To describe instruments for making precise conductivity measurements in plant, laboratory, or classroom, the Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, has just revised its catalog, "Apparatus for Electrolytic Conductivity Measurements in Laboratory and Plant." It should be of special interest to anyone who is considering new equipment and

wants the very latest specifications on instruments, conductivity cells and accessories.

This revised publication presents much the same data about methods of measurement and notes for selection and use of the apparatus as did the previous edition. But, in addition, it illustrates and describes a Signalling Conductivity Controller and several new industrial cells which have become available since the earlier edition was issued.

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Dictionary of Textile Terms

New fibers, new constructions, new finishes, and new fabrics are rapidly adding new words to the already extensive vocabulary of textile terms and adding to the confusion of the average shopper. The new 89 page glossary issued by Dan River Mills defines many of these new terms as well as the better-known processes and fabrics and includes the most important trade names. The glossary may be obtained by writing the Dan River Mills, 40 Worth Street, New York, N. Y. or to Danville, Va.

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New Electronic Relay Announced by General Electric

A new electronic relay for amplifying the very limited current transmitted by delicate control contacts or high resistance circuits, thus materially increasing the application range of many control devices, has been announced by the Industrial Control Division of the General Electric Company. Operated by any material having a resistance of from 0 to 500,000 ohms, or even greater if necessary, the new relay is especially suitable for controlling liquid levels in tanks and boilers, sorting metallic parts by size, detecting broken threads in textile machines, and as a limit switch requiring extremely light pressure to operate.

Small and light in weight, thus facilitating easy installation, the new relay consists of a standard type electronic tube, a supply transformer, and an electromagnetic relay—all mounted in a totally enclosed, weather-resistant enclosure suitable for wall or machine mounting.

In operation, the electromagnetic relay in the device is kept energized as long as the controls connected to the input grid circuit of the electronic tube remain open. The instant these contacts close, the relay is de-energized. A built-in time delay feature prevents chattering when the contacts in the input circuit are momentarily closed. A contact arrangement on the electromagnetic relay permits the device to be used either to make or break a load circuit when the actuating contacts connected to the input circuit on the electronic relay are closed.

G. E. electronic relay.

A New Method for Appraising Garments and Textiles Used By the Army Employs

Physiological Testing

Textiles are commonly tested for such physical properties as breaking and tearing strength, air permeability, water permeability, water vapor permeability, thickness, compressibility, and insulating properties under extreme and standard conditions. Measurements of other qualities, such as wear, flexibility and "slideability," have also been made or attempted. In many cases the measurements are exact and completely reproducible. Although they accurately define the physical properties for which the textile was tested, experience indicates that information derived from the physical laboratory does not correlate completely, and sometimes not at all, with the experience of the wearer, who in this case is the soldier in the field.

And in the Army, as in civilian life, it is the ultimate consumer who must be considered, with even more emphasis on his needs and desires, since the soldier's effectiveness and indeed, his life, may depend on their satisfaction. Clothing and textiles are war machinery for both offensive and defensive purposes, and the needs of the peace time consumer provide no adequate precedents for judgment. We are primarily interested in improving the soldier's efficiency.

One does not need to stretch the imagination to seek at least some of the causes for the divergence between results obtained by physical tests and results noted by the wearer. Some of the divergences have no doubt arisen because the textile designers have not known what properties needed to be determined; others because the test conditions did not correspond to field conditions; yet others, because the properties of textiles, as such, are altered by making them into garments; and again others because wear by different individuals imposes different conditions on the garments themselves. No two individuals have exactly the same characteristics of shape; they do not move or even sit alike, and their psychological and physiological responses to the same stimulus may be completely different. In short, we have to deal with the problem of human variation which is generally but tacitly recognized by all of us in our dealings with each other. Although this may seem to be a self-evident platitude, it is only by actually making measurements on the individual wearers, preferably under the very conditions under which the clothing is to be worn, that it is possible to draw valid conclusions concerning the warmth, utility and comfort provided by garments and other articles of clothing such as shoes, hand and sleeping gear. Unfortunately, within the limits of time imposed by geography, it is impractical to make world-wide tests on an adequate scale. Consequently, one has recourse to physio-

Fig. 1. Testing Arctic clothing at a temperature of 60° below zero. Treadmill in cold room at the Army's Climatic Research Laboratory. Each of the men have a cable connected to them which records the skin temperatures from 18 points on their bodies.

logical laboratory testing of uniforms, whether they are designed to be worn at the Poles or at the Equator.

In physiological testing as practised by the Quartermaster Corps, climatic conditions representative of the area for which the garment is designed are selected and reproduced. For example, garments designed for Arctic use are laboratory tested at temperatures down to —40° F, with or without wind, while those designed for humid, tropical use are tested at conditions as extreme as 85° F and 85% relative humidity. Although these conditions are representative of the tropics, temperature of 140° F may be attained. Rain or snow may be added when appropriate. Although not every possible combination of climatic conditions is simulated, at least comparison can be made under standard and reproducible conditions, and it is more nearly possible to predict what will happen in the field. By such measurements as skin temperature and sweat rates, and by determining *Clo* values, it is possible to gain useful information regarding the warmth or coolness of clothing, and the warmth of hand and sleeping gear. Parenthetically, one should observe that the *Clo* is the amount of insulation provided by a suit which affords comfort, at least to the average American, at 70° F when he is inactive in still air. Tolerance time, or the time it

takes before an individual reports that he is unbearably cold (or hot), is also useful, provided skin temperatures are taken in order to be sure that the wearer is actually cold and not shamming.

But not only does the physiological method yield measurements: from it one also gets information concerning the functional adaptation of a garment to the manifold purposes to which it is to be put. Does it cause skin irritation or discomfort? Does it impede the wearer's vision? Does it impede entry or exit through narrow openings? Does it hamper movement or limit dexterity, so that the soldier is less able to carry out his duties, be they firing a weapon, operating such delicate instruments as range finders, radar and radios, splicing wire, digging out a foxhole, or for that matter, performing any of the widely different tasks which may confront him? Although it has sometimes, as in the case of compressibility and thickness of garments made from different types of pile, been possible to establish a fair qualitative correlation between physical characteristics and physiological measurements, complete quantitative correspondence has not yet been attained. Indeed, even physiological testing does not always tell us what will happen in field wear. Fortunately, it is possible definitely to eliminate many unsuitable textiles or combinations thereof, and frequently, as is the case with sleeping gear, prediction agrees with field experience.

Even this limited success would surely justify the use of the physiological method, but the method does do more. It has, as will shortly be shown, furnished information which not only has led to the improvement of textile design to meet special conditions, but also has been the basis for new designs which have improved the functional adaptation of clothing provided for the soldier. A few examples will serve to illustrate this point. Superficially, it would seem that handgear presented only trivial problems. If gloves or mittens turned out to give insufficient protection, why not increase the thickness? Surely that should suffice. But experiment on the subject at —20° F showed that encasing the hand in a thumbless mitten about one inch thick did not keep it warm when the wearer was completely inactive, and in this case dexterity and other necessary properties had been sacrificed to protection as well. A simple analysis, based on elementary physics, soon showed that added thickness was accompanied by so disproportionate an increase in the radiating surface that the total insulation was much less than might otherwise have been expected. This is graphically shown in Figure 2. The phenomenon has, of course, long been understood by heating engineers. More rigorous application of the study leads to the somewhat discouraging conclusion that handgear constructed of materials known at present cannot keep the hands of an inactive person adequately warm at temperatures much below freezing, and certainly not in sub-zero weather. Activity materially decreases the insulation needed. This is graphically shown in Figure 3. Similar analyses tell us why mittens are warmer than gloves. Fortunately, there are ways out of this dilemma. The individual who must sit still can often be supplied with electrically heated handgear; others can exercise in one way or another, thus increasing the blood flow to the hands and

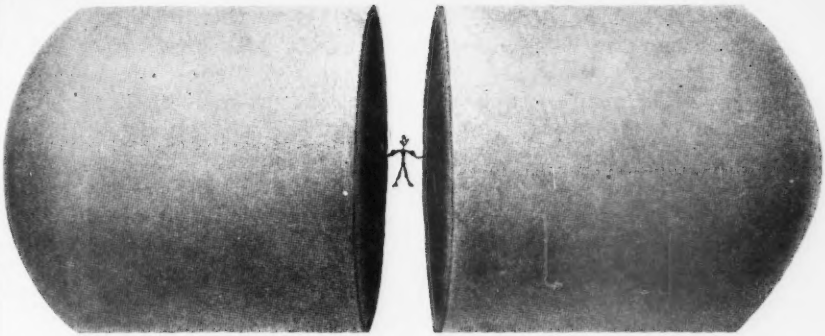

Fig. 2. Gargantuan glove finger needed for warmth at — 10° F. A 44 ft. glove finger diameter is needed to maintain skin temperature of fingers at comfort level in moderate vasoconstriction with subject at rest.

with it their heat supply. Again, at temperatures where handgear can be adequate, many gloves apparently properly fitted result in cold fingers. Observations indicate that the construction of gloves without points of constriction and with curved fingers results in warmer hands.

Another example concerned with cold weather clothing is that of pile garment assemblies. It has repeatedly been shown in the laboratory that insulation for a wide variety of textiles is proportional to thickness, and that the thickness involved is that of the layer of trapped air. Accordingly, one might suppose that the wearer would detect a difference between similarly constructed pile ⅜ inch and ⅝ inch thick. Experiments show, however, that with garments made of 50% alpaca-50% mohair, single faced pile, worn by subjects sitting still, the difference indicated is insignificant. This is understandable, since one notes that at a pressure of .1 pound per square inch the thickness of these fabrics differs by about .02 inch, equivalent to about .1 *Clo*, which represents an imperceptible difference, at least where the total insulation is equivalent to about 3.0 *Clo*. Wool pile fabrics ½ inch thick perform in a combination of garments as might be expected. Since they are less compressible and therefore thicker under the same load, they are distinctly warmer. Consequently, provided excessive distortion of clothing due to wear and laundering can be avoided, this fabric appears to be the textile of choice.

Studies of these garments made on man clearly demonstrate the importance of proper fitting and sizing. In sizing the thickness of the pile must be considered. For example, a garment constructed of material ½ inch thick must be about 2½ inches larger in circumference than similar garments made of material ⅛ inch thick. A recorded pressure of 8 pounds per square inch over a flexed elbow certainly resulted in very great compression of the fabric at this point, and was also accompanied by a corresponding decrease in local insulation. But such effects are not only localized. A pressure of about ½ pound per square inch will suffice to stop the capillary blood flow in the area, which results in at least

some superficial cooling. Re-design following such observations follows as a matter of course.

A study of the evolution of clothing for tropical climates is perhaps more interesting. It has long been known to physiologists that the maintenance of body temperature at a level close to normal was chiefly due to heat loss by evaporation, whenever the temperature exceeded 83° F. Above skin temperature, normally 93° F, evaporation must account for all of the heat lost. This is, of course, reflected in the general approach to nakedness adopted by natives in tropical areas. To a soldier, this otherwise desirable state is unavailable. He must be able to struggle through jungle without being readily seen, and must avoid the scourge of the jungle fighter—malaria —which could account for many more casualties than the Jap. In short, he must be clad.

About a year ago a new attack was made on the problem to answer this question. At that time the Army was supplied with fatigue garments made of herringbone twill. This fabric is not tightly woven and weighs about 8 ounces per yard. It had originally been thought loose enough to permit adequate circulation of air. Presumably, it had been thought to be cool. It was known to be strong and durable. It was, however, believed that cooler garments could and should be made. It had been moreover, argued that a loose and more open fabric should provide ready access of air and easy evaporation at the skin surface, and therefore be cooler. In order to maintain the strength needed for military purposes it was likely to be at least as thick as the standard herringbone twill as used in fatigues, which was already known to be hot. At about this time a recommendation was made for the adoption of Byrd cloth, which is a light weight windbreak fabric. It seemed to some that the latter property would be undesirable. Debate could not decide the question posed, so consequently a small expedition was sent to test garments made from a series of textiles, ranging from open cellular weave, worn by the British soldier in Africa, through herringbone twill and 8.2-oz. cotton twill, to Byrd cloth. The preference of the test team under the conditions prevailing in Florida over the test period was unmistakably expressed for poplin, or for Byrd cloth if it could be made stronger. Not only did these textiles seem cooler; they were lighter both wet and dry, and seemed to hamper the wearer less. Last, but certainly not least, they gave better protection against mosquitoes.

Entirely apart from the validity of the conclusions reached, these observations gave valuable clues for subsequent investigation. Physiological tests have clearly indicated that lighter weight and thinner textiles impose less heat stress as measured by the sweat rate. Count of mosquito bites through the textiles in the laboratory and in the salt marshes of Florida have shown that a close, tight weave will materially reduce the number of successful bites, and physical tests of textiles show that their permeability to water vapor is within wide limits, governed by their thickness, and that it is independent of the closeness of the weave. It also seemed that water repellent treated fabrics might become less clogged with sweat and therefore more readily permit evaporation. Thus, even if the problem is not yet com-

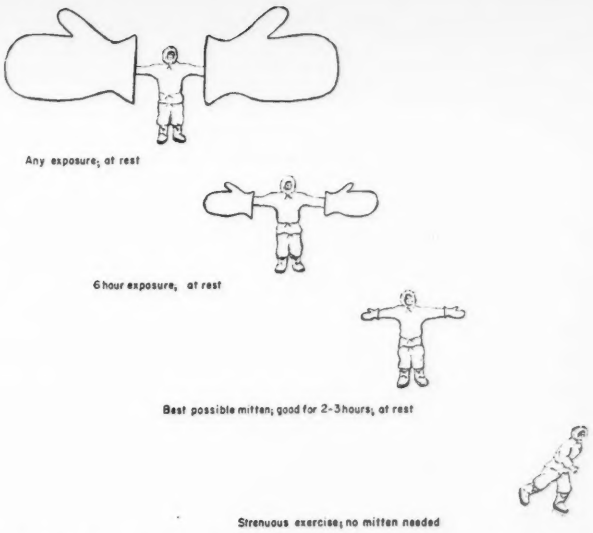
Any exposure, at rest
6 hour exposure, at rest
Best possible mitten; good for 2-3 hours, at rest
Strenuous exercise; no mitten needed

Fig. 3. Relative size of mittens needed for different exposure times at — 20° F.

pletely solved, in practical terms, it has been so clearly defined that we know what sort of textile modification is necessary.

Finally, when we turn to textiles designed for use in garments intended for protection against rain, it has been shown that even textiles which exhibited low air permeability, relatively high resistance to wetting by falling drops, and to the passage of water under pressure, provided unsatisfactory protection for the wearer when worn as garments. Nor was the protection apparently directly related to the measurements. Further, garments made of completely impermeable textiles are not provided with adequate ventilation, so the soldier becomes wet from sweat when active, only to become cold when he stops activity, at least, at temperatures likely to be met in this country or in Europe. Also, waterproof garments are usually heavy. The development of a lighter weight poncho, made from coated Nylon, provided a garment weighing less than the Army raincoat and because of its design, provided better ventilation. It also weighs much less than the poncho made of raincoat material. Since the light weight garment may replace both items, the soldier's load can be reduced by 3½ pounds.

Altogether, a start has been made on the long road which may ultimately reconcile physical test results with those obtained by physiological means, and one can hope finally that both methods together will lead to valid predictions concerning utility to the wearer. But even though this goal is not yet attained, the physiological method has been shown to be helpful in comparing garments with respect to warmth or coolness and moisture penetration, as well as with respect to their functional utility. It has also been a means of suggesting changes in design of both garments and textiles.

Research That Has Furnished the Background for Current Practice is described in

The Story of Coated Fabrics

I—Development of Oilcloth

By FRANCIS J. TUTTLE

Research Chemist, R. B. H. Dispersions, Inc., Bound Brook, N. J.

The evolution of methods for the manufacture of coated fabrics has followed a sequence as the three main classes of raw materials became available, commencing with vegetable oils and leading to the modern synthetic resins. Much of the current technique follows closely some of the practices described in these articles. The following article deals with the development of oilcloth. Processes for coating textiles with rubber and with the pyroxylin-coatings will be described in an early issue of TEXTILE RESEARCH.

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Fabrics coated and impregnated with various substances have been used for centuries and their use continues on a huge scale today. There is hardly a home where a piece of oilcloth, artificial leather, or rubberized cloth is not to be found. Modifications of these types now have a vital role in protecting our men in the armed forces. These items are so commonplace that few stop to realize the long background of manufacturing experience of this industry in which applied chemistry moved along with mechanical ingenuity.

The evolution of coated fabrics followed the sequence in which three classes of raw materials became available: vegetable oils, rubber, and latest, nitrocellulose and synthetic resins.

It is generally agreed that the first coatings for cloth were drying oils, probably linseed. The belief is widespread that the first oilproofers were seafaring men, sailors, and fishermen, who treated their canvas coats and overalls with oils to protect themselves from sea and weather.

These early "oilskins" were prepared by rubbing oil by hand into the garment. In some instances the hand rubbing was replaced by brushing or dipping. After allowing the coat to dry for several months and then repeating the process four or five times, an expensive but thoroughly waterproof product was ultimately obtained.

Factory production of oilskins began in Scotland and embodied the application of the home art to commercial production. The cotton garment was first assembled in its entirety and the oil treatment was then completed to render the article saleable as waterproof.

This procedure gradually gave way

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to machine oiling, which involved treatment of an entire bolt of cloth prior to the cutting and sewing of the garment. In practice it was found necessary to "afteroil" the machine-treated, assembled garment to seal the needle holes resulting from the sewing of the oiled fabric.

It was discovered early that impregnating the textile with the drying oil resulted in "tendering" or loss of tear and tensile strength. On the other hand, a tenacious surface coating increased these properties at the expense of adhesion to the fabric. Many proofers eventually used a priming coat of an oil-in-water emulsion to seal the pores and capillaries as much as possible and to retain subsequent coats on the surface. A typical priming daub was as follows:

Boiled Linseed Oil	50 lbs.
Carbon Black	10 lbs.
Turkey Red Oil	10 lbs.
Water	50 lbs.
Ammonia (Aqueous)	1 lb.
Petroleum Thinner	24 lbs.

This mixture was emulsified and applied on each side of the cloth.

The early factory products were crude and possessed many undesirable characteristics. When stored under conditions of warmth and humidity for any length of time, a progressive stickiness developed making them unsuitable for wear. If they were stored before they were well dried, heat from oxidation accumulated and spontaneous combustion caused many fires.

With the development of the art, much has been done to overcome these defects. Through the years, closely guarded formulations and procedures were developed by the "oil-boiler" which were claimed to prolong the useful life of the product. With the development of driers and forced drying the long ageing period was gradually reduced without an increase in the fire hazard.

Fig. 1. Cross-section oilcloth, one coat (65 ×).

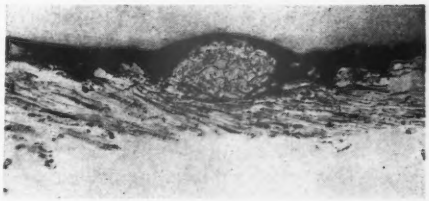

Fig. 2. Two coats on fabric (65 ×).

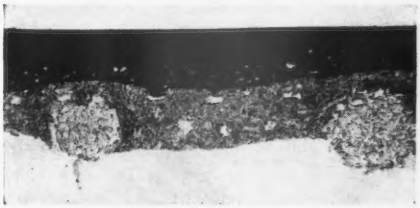

Fig. 3. Finished four-coat farbic (65 ×).

In 1860, William Tristram patented a method for finishing silk with a nontacky surface. His process was the beginning of the oilsilk industry in England and has not changed basically since the original application, although modifications have been introduced. In this process silk is fed from a roll through a bath of the proofing varnish, passed between two rolls or doctor knives to remove the excess and conducted up in a tower some fifty to sixty feet above the floor to another roller,

and thence back down again to a rewind roll. The tower is merely a heating chamber where the silk is dried; the temperature may vary from 80° F at the floor level to 200° F or over at the top of the tower. With drying oils the process is exceedingly slow, cloth passing through the bath at from six to ten yards per hour. One application is deemed sufficient for a matte finish. Fine gloss requires a second application.

The next step in the process consisted in spreading the oiled silk on smooth steel plates which were heated to about 100° F and applying several very thin coats of shellac which removed the tackiness. After this application the silk was festooned in a cool oven to dry and age.

A somewhat similar treatment for heavy cotton goods, duck, and canvas was popular both in England and in this country for the production of waterproof paulins and covers. English "Black Oil" was generally used for this purpose. This oil was originally prepared by heating linseed oil with a vegetable black and lead drier for several hours. It was found, however, that prolonged heating with a correspondingly greater increase in body, was more satisfactory for proofed goods; hence the term "double-boiled oil." As the varnish was slowly cooling, an additional drier, such as cobalt resinate, was sometimes added. The gray duck was passed through the bath of proofing compound, the excess oil was removed, and the impregnated duck was then hung in open air rooms to air dry for several days. The pieces were then cut to size and laid on large tables where the oil was brushed on by hand. The drying period was repeated, followed by brush coating on the opposite side. To finish a piece of fabric, the face was given a final brush coat; and air ageing of at least several weeks was considered necessary to produce a finish that would not mark along creases or crack when bent. The complete procedure added from 20 to 24 dry oz. of coat-

Fig. 4. Photomicrograph of matte-finish oilcloth (70 ×).

Fig. 5. Photomicrograph of gloss-finish oilcloth (70 ×).

ing to a square yard of cloth. The hand brushing was gradually replaced by knife coating and high-temperature drying generally replaced the long air dry.

The origin of the oilcloth is legendary. It is reported in England that many centuries ago a farmer was seeking a flexible material in which he could keep his seeds dry. Finding no such material on the market, he reputedly bought a piece of unbleached linen, placed it on a table and painted it by hand with oil paint. This he allowed to dry. So pleased was he with the result that he repeated the operation, this time stretching the coated cloth while it dried, obtaining thereby a smoother finish.

Gradually more men took up the work. The cloth was bought in longer lengths, spread on longer tables, and was painted simultaneously by several men. By stretching the cloth on frames and drying it in a heated room, production was somewhat increased. Increasing the number of coats also improved the quality.

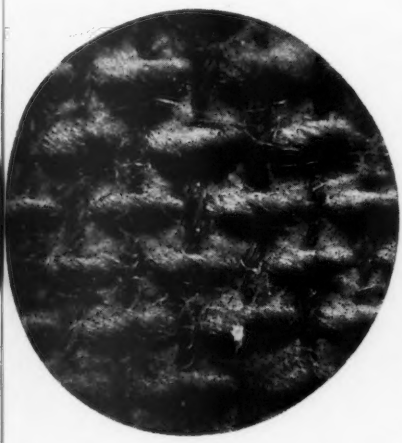

Fig. 6. Photomicrograph of fabric oilcloth backing (14 ×).

The name "oilcloth" may have been derived from the oil paints first used to paint them, or from the fact that the treated paulins mentioned above were already in use when painted cloth appeared on the market. Gradually the term oilcloth was applied in a generic sense for all types of painted cloth, impregnated cloth, and even for floor coverings.

An English law enacted about 1483 states that "no merchant shall import into the realm, to be sold, any painted cloth," indicating that the product was well known and manufactured not only in England but in other countries as well. In 1636 a man named Greenbury was granted a patent for painting wool with oil colors for use as imitation tapestry. The patent claims included the painting of silk with similar colors for use in windows. In 1694 an English patent was granted for a process ". . . to print upon oyle cloath, gold and silver flowers and other figures in all sorts of colors."

Up to 1742 the records give no indication that such painting and printing was anything but small-scale handwork. In that year the J. G. Benecke oilcloth factory was erected at Hanover in Germany. In 1750 the Nottenagel factory was built in Frankfort and it continued in production until 1845. In 1754 Nathan Smith erected the first known oilcloth factory in England near Knights Bridge in London. Nine years later he was granted a patent for a coating containing color, linseed oil, and beeswax.

Smith also claimed the invention of a machine for use in applying his composition to cloth, and his description of this primitive calendar follows:

"By reason of the weight of the hollow iron roller, and from its heat from the fire within, the composition is pressed, sunk into, or squeezed through the cloth . . . they unite together and become one body."

In the early days of oilcloth, woolen, linen, and silk fabrics were used as the base cloth. Gradually the wool and silk were discarded and for many years only linen was used. When cotton cloth became cheaper than linen it gradually replaced the latter.

As the industry grew in England, more and more operations were handled by machines adapted from the textile industry. The industry developed in continental Europe along similar lines. But it was around 1854 before drying ovens into which the cloth could be festooned were introduced.

The first oilcloth produced in America was made by John Dorsey in Philadelphia in 1809. His process closely followed the established procedure then in use in England. His product was marketed as a floor covering.

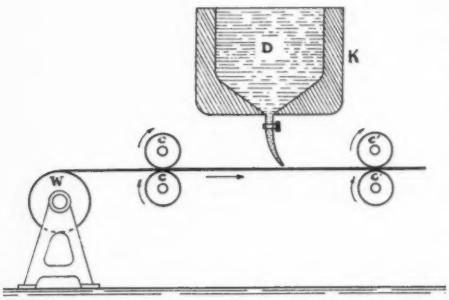

Fig. 7. An early machine for preparing tarpaulins.

The cloth was led from roller *W* between two pairs of rollers *C*, *C* and C_1, C_1 which were approximately 6 feet apart; the rolls *C* were made of wood while the rolls C_1 were iron; both were hollow for heating with hot coals. Rolls *C* smoothed and stretched the cloth. Preheating was determined by the penetration desired. The impregnating compound *D*, in a hot-water, jacketed vessel *K* flowed onto the cloth and was distributed by the upper roll C_1.

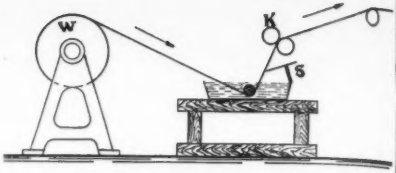

Fig. 8. An early impregnating machine for treating silk and linen with varnish.

The fabric from roll *W* was passed into the oil bath under the removable glass rod; *S* was a sharp doctor blade which removed some of the excess varnish; two wooden rolls *K* squeezed the excess varnish from the cloth which was then conducted to an ageing room.

About 1840 a man named Crockett started a factory in Newark. His process developed a product quite unlike the English and continental oilcloths in its light weight and pliability. It became known as American cloth or leather cloth. In 1857, the Leather Cloth Company, Ltd., became the sole European manufacturers of Crockett's product with a factory at West Ham in London.

The "American cloth" was produced and marketed in large quantities through the development and application of mass-production methods which far outstripped any handmade material in cost and uniformity. The product was widely used as a cheap, serviceable table covering. The introduction of machine printing to the industry in 1870, in place of hand block printing, eventually made possible the rapid production of finely decorated oilcloth for use as a rugged, washable wall covering.

ABSTRACTS

Members of Textile Research Institute, Inc., desiring complete copies of articles abstracted may obtain photostat copies at cost by addressing the Institute's office, 10 East 40 St., New York 16, N. Y. The price of a photostat negative is seldom more than 30 cents per page of original text.

Translations of articles appearing in foreign language publications and abstracted in TEXTILE RESEARCH, *will be furnished at cost when the original publication is obtainable.*

A list of periodicals abstracted in TEXTILE RESEARCH *and the abbreviations used appeared on page 32 of the January, 1944 issue of* TEXTILE RESEARCH.

ANALYSIS: TESTING: LABORATORY METHODS

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Analysis of Absorption

An analysis of the water absorption isotherm of wool. J. B. Speakman. *Trans. Faraday Soc.* **40**, 6–10 (Jan. 1944).

The water absorbed by wool appears to be of three types, viz., α-water, which combines with hydrophilic side-chains with great evolution of heat; loosely bound β-water, which is responsible for the fall in rigidity of wool during water absorption, and is associated with the peptide groups of the main protein chains, combination being complete when each peptide group is associated with one water molecule; and water condensed in capillary spaces at relative humidities greater than 80%. Below 80% R.H. it is shown that the total water absorbed by wool may be calculated by means of the empirically derived equation:

$$A = 0.1012\ H^{0.395} + 0.002754\ H^{1.78}$$

Where "A" is the total water absorbed, and "H" is the relative humidity. The first term represents the α-water, and the second term the β-water. This equation is derived by means of the Peirce equation (*J. Text. Inst.* **20**, T-133, 1929) using 118 as the average molecular weight of the amino acid residues in wool.

Determination of Cotton Content

Tests for cotton content of asbestos textiles. Anon. *Asbestos* **25**, 12–18 (May 1944).

Several methods are described for testing the cotton content of asbestos textiles—yarn, cloth, tape for electrical purposes, etc.

Color of Wool Blends

Spectrophotometric prediction of color of wool blends. E. I. Stearns and F. Noechel. *Am. Dyestuff Reptr.* **33**, 177–80 (Apr. 24, 1944).

The visual spectrophotometer (VS) can be used advantageously to determine tolerances within which a color sample should fall and still be considered a good match. Although this perhaps may be done visually, the use of the VS eliminates the difficulty introduced by the variation between visual matches under daylight and artificial light. Some uses of the VS in the practical everyday dyeing of wool blends predict the differences to be expected as a result of (1) difference in fiber diameter in two lots of the same origin, and (2) difference in origin though of the same grade, and detection of "dyeing randomness." Experiments conducted to determine what relation in spectrophotometric values may be used to direct the formulation of a particular color have resulted in the design of a special cam for use in the VS, following the hyperbolic equation:

$$f(R) = \frac{100 - R}{b(R - 1) + 1}$$

where R = % body reflectance and b = a constant (0.15 for wool), which plots the additive junction f(R) in the useful form of a straight line. On a plot having this ordinate scale, data at wave lengths from 400 to 750 $m\mu$ will fall on a straight line, and the same law applies to various reflectance values as well for wool of varying diameter. Using this junction, points predicted have been found experimentally to agree very closely with the curve of the

actual mixture. The described prediction method, however, represents only one phase of the commercial application of VS formulating.

CHEMICAL AND PHYSICAL RESEARCH

*

Cellulose Derivatives

Factors in molding cellulose derivatives. W. O. Bracken and F. E. Piech. *Ind. Eng. Chem.* **36**, 452–6 (May 1944).

Strain in translucent cellulose acetate injection-molded or sheet-stock plastics appears related to plastics temperatures, pressures mold (or chase) temperatures, rates of filling mold (injection), and solvent content (sheet stock). Strain patterns as evidenced by placing the molded pieces between crossed Polaroid films have been photographed. High temperature and pressures produce pieces of minimum strain pattern, closest mold reproduction, and heaviest weight. Low rate of filling mold aids in forming bubble-free pieces. Side gating is more effective than corner gating in producing pieces relatively free of strain. Solvent content in block prior to baking, baking temperature, and cooling pressure are critical factors in achieving strain-free cellulose acetate sheet stock.

Cellulose Dispersions

Flow characteristics of dispersions of cotton and regenerated cellulose rayon fabrics in cuprammonium. Viola C. Jelinek. *Ind. Eng. Chem. Anal. Ed.* **16**, 172–78 (Mar. 1944).

Flow pressure and fluidity-velocity gradient graphs were used to determine the flow properties of cuprammonium dispersions of cellulose fabrics and to evaluate the method of calculating the fluidity values. The limits of application of the kinetic energy and velocity gradient adjustments were determined for cellulose-cuprammonium dispersions, under experimental conditions very similar to those recommended by the American Society for Testing Materials. The viscometer and buret consistometer were compared in the fluidity technique.

Creep and Relaxation

Drift and relaxation of rubber. M. Mooney, W. E. Wolstenholme, and D. S. Villars. *J. Applied Phys.* **15**, 324–37 (Apr. 1944).

Drift tests lasting 8 years have been carried out on rubber blocks in compression at 35° C. Rate of drift, initially high, attains a low constant value in 200 days or less. The initial, rapid drift is termed transient drift; and the slower, constant drift is termed steady drift. Drift varies considerably with the type of accelerator in the compound. Ureka giving the lowest drift of the accelerators tested. A new method has been developed for measuring stress relaxation in tension. The stress is measured to 0.1 percent by the resonance frequency of lateral vibrations of the stretched sample. The vibrations are impressed on the sample by a mechanical oscillator in which the source of vibrational energy is a steel wire which is under adjustable tension and is kept in circular vibration by a pair of air jets. Relaxation measurements extending over many months are reported on a soft vulcanized rubber at elongations from 10 to 400 percent at 35° and 70° C. The experimental data can be fitted by a two-term stress equation of the Tobolsky-Eyring form representing two slip mechanisms, or transient and steady relaxation. Steady relaxation follows an exponential decay law; and this means that the residual stress goes to zero at infinite time. Other stress relaxation data are reported for rubber tested at 150 percent elongation, at temperatures from 35° to 113° C. in air and in vacuum. Air, as compared with vacuum, produces little effect at 35°; but at 70° and higher, the rate of steady relaxation is greatly increased. Thus oxidation appears to be the major factor in steady relaxation at elevated temperatures. Total transient relaxation is unaccountably increased by vacuum and by heat. A modification of the Tobolsky-Eyring equation is developed for steady relaxation. For transient relaxation a new theory is developed which leads to the Tobolsky-Eyring equation, but involves different interpretation of the parameters. In this theory, transient relaxation is attributed to rupture of secondary chemical bonds or crystal forces.

followed by longitudinal slippage of chain molecules, with partial or local equalization of tension along the chains. The crystallites then reform, and the rupture and slippage process is repeated. The energy dissipation is attributed primarily to release of local elastic stresses following bond rupture. Transient relaxation is complete when the tension is completely equalized over the total length of each chain between cross links. Neither of the new equations can be distinguished from the Tobolsky-Eyring equation on the basis of present data.

Diffusion Studies

The effect of waxes and inorganic powders on the transpiration of water through celluloid membranes. P. Alexander, J. A. Kitchener and H. V. A. Briscoe. *Tran. Faraday Soc.* **40**, 10–19 (Jan. 1944).

An apparatus has been devised to measure accurately the rate of diffusion of water through relatively impermeable membranes such as celluloid into air. The rate is found to be independent of small hydrostatic pressures. The rate of evaporation from celluloid is considerably reduced when extremely thin films of various fatty substances are applied to the celluloid. Natural waxes are particularly active in this respect. This supports the idea that the natural waxy layers present in the epicuticle of insects and the epidermis of plants are responsible for water conservation. Finely divided, inert, inorganic powers such as carborundum have no effect on the evaporation from a clean celluloid film, but increase that from one coated with a water-resistant fat film. The system studied was intended to simulate the process by which inert dust insecticides operate, and appears in many ways to exhibit parallel behaviour.

Elasticity of Rubber

Theory of the elasticity of rubber. Hubert M. James and Eugene Guth. *J. Applied Phys.* **15**, 294–303 (Apr. 1944).

Natural rubber is the prototype of an important class of materials consisting of long flexible molecules which interact with each other in a particular way. Some of the properties of bulk rubber are strikingly similar to, and may be understood by a consideration of, those of single flexible molecules. For a complete understanding of the behavior of rubberlike materials it is necessary to understand the way in which they are built up from the component flexible molecules. In vulcanized materials, in which plasticity is suppressed, intermolecular bonds link the molecules into a coherent network, very irregular in detail but isotropic and hemogeneous on the average. In lightly vulcanized materials these bonds are relatively few, and bring relatively small portions of adjacent molecules into fixed relations to each other. For the most part the interaction of neighboring molecules in the material is that characteristic of liquids. It is the presence of the intermolecular bonds, which link the molecules into a network and thus control its form, which differentiates rubberlike materials from liquids. It is the small number of these bonds, and their weak control of the form of material through the entropy rather than the internal energy, which differentiates rubberlike materials from ordinary solids. On the basis of this picture of the structure of rubber there is derived a form for the stress-strain curves at moderate extensions which is in good agreement with experiment.

Physical Properties

Relation between the chain length of thread molecules and the physical strength properties of fibers made therefrom. H. Staudinger. *Kunstseide u. Zellwolle* **24**, 511–12 (Oct. 1942) (through *Bull. Inst. Paper Chem.*, 1944, **14**, 255).

Artificial fibers prepared from cotton and ramie nitrates by spinning from their solutions had the same degree of polymerization as the non-nitrated native fibers, yet possessed considerably lower physical strength properties. This shows that, in addition to the D.P., the arrangement of the thread molecules is responsible for the excellent physical strength properties of the native fibers. The experience that the strength properties of viscose rayon increased with the concentration of the viscose was confirmed. Under the same spinning conditions, cellulose of a higher D.P.

yielded a better fiber than one of a lower D.P. Fibers prepared from molten polyamino-caproic acid polymer showed a very considerable increase in strength with relatively little increase in chain length. That this result is not caused by cross bonding of CO and NH groups is deduced from the fact that fibers with such properties were also obtained from polyesters if spun from the molten material. An attempt to apply spinning from the molten material to ethylcellulose resulted in fibers which, in spite of a D.P. as low as 100, showed relatively good physical properties.

Properties of Rubberlike Materials

Hysteretic and elastic properties of rubberlike materials under dynamic shear stresses. J. H. Dillon, I. B. Prettyman, and G. L. Hall. *J. Applied Phys.* **15**, 309–23 (Apr. 1944).

The nature of hysteresis in products such as pneumatic tires, solid tires, and transmission belts is analyzed and the requirements of a laboratory test for evaluating the relative hysteretic characteristics of natural and synthetic rubber stocks are developed. The significance of various definitions of the "hysteresis defect" in rubberlike materials is discussed. A forced resonance vibrator in which rubber samples are deformed in shear at frequencies of 20 to 300 cycles/sec., shear strains of 0.05 to 0.35, and temperatures of —20 to 120° C. is described. Experimental results obtained with natural rubber and GR–S gum and tread stocks are presented. The hysteresis index $\omega\eta$ is found to be nearly independent of dynamic shear strain while the dynamic modulus G decreases moderately with increasing dynamic strain. Neither $\omega\eta$ nor G depends upon the height to diameter ratio of cylindrical samples. These results are at variance with those obtained by previous investigators who, employing compressive vibrations, have reported marked dependences of both modulus and friction upon dynamic strain and the "shape factor" of tread type stocks. In agreement with previously reported work, G is found to be independent of frequency and $\omega\eta$ only slightly dependent upon frequency, for tread type stocks. Results are presented for stocks based on Buna S type copolymers with varying monomer ratio and on N-type Butaprenes, Neoprene, and butyl rubbers.

Physics of Color

Physical concepts: radiant energy and its measurement. O.S.A. Committee on Colorimetry. *J. Opt. Soc. Am.* **34**, 183–218 (1944).

The psychophysics of color. O.S.A. Committee on Colorimetry. *J. Opt. Soc. Am.* **34**, 245–66 (1944).

These two reports are Chapters V and VI of the forthcoming report of the O.S.A. Committee on Colorimetry which after the war will be published in book form. These two chapters provide the best reference authority one can have in matters relating to fundamental concepts of the physics and psychophysics of color.

BLEACHING: DYEING: FINISHING

★

Acid and Basic Dyes

New combinations of acid and basic dyes. Anon. *Silk and Rayon* **18**, 428, 443 (Apr. 1944).

As is well known, combination of acid dyes or direct cotton dyes with basic dyes yield compounds insoluble in water. These are, however, soluble in alcohol, and it is suggested that these combinations might be of considerable value for dyeing the newer synthetic fibers, or fabrics finished with synthetic resins. In these combinations, the high tinctorial value and purity of shade of the basic dyes is retained along with the light fastness characteristic of the acid dyes.

Dyeing of Nylon

Some new dyeing methods for nylon. Anon. *Silk and Rayon* **18**, 318 (Mar. 1944).

When applied by ordinary methods vat dyes generally give considerably weaker shades on nylon than on cotton or viscose. English patent 534,085 offers a method for

overcoming this difficulty. Instead of applying the color in the usual 30–60° C. range, this method employs temperatures at or near the boil. Formaldehyde sulfoxylate (Rongalite) is substituted for sodium hydrosulfite, as the latter is unstable at elevated temperatures. English patent 552,015 discloses a means of making nylon resistant to direct cotton dyes. It is stated that the normal affinity of nylon for these colors is entirely, or almost entirely, suppressed in the presence of certain compounds containing sulphonic acid groups. Among the effective materials are mentioned turkey red oil, Nekal BX and other alkylnapthalene sulphonic acids, Prestabit oil, and the well-known dye intermediates, H-acid and Schafer's acid.

Dyes from Aminoguanidine

Azo dyes from aminoguanidine. R. Norris Shreve, R. P. Carter, and J. M. Willis. *Ind. Eng. Chem.* **36**, 426–30 (May 1944).

Aminoguanidine has been diazotized and hot-coupled with various intermediates to furnish a whole new series of azo dyes which possess good dyeing properties on animal fibers such as silk and wool, particularly in conjunction with a mordant. The dyes are of various shades with the browns and oranges predominating. The coupling of the aminoguanidine diazonium hydroxide or of its isomer is carried out in a hot aqueous solution under controlled conditions of pH to give the various dyes. The latter are soluble in alkaline solution, but they are precipitated by acids.

Package Dyeing

Package dyeing with vat colors. O. W. Clark. *Textile World* **94**, 107–9 (Apr. 1944).

Description is given of a study of some of the fundamental factors in the vat dyeing of yarn wound in package form on perforated tubes. Cross-sectional views are shown which illustrate the effect of package size on levelness of dyeing, the improvement in levelness at higher rates of flow, and the effect of temperature. It was found that a high rate of flow promotes level shades, that careful judgment is needed in the selection and use of leveling agents. Three commercial formulas are given which were worked out as a result of the series of experimental dyeings.

Wool Dyeing

Microscopical observations of wool dyeing. IV. Quantitative study of effect of time and temperature. Willard H. Watkins, George L. Royer and Henry E. Millson. *Am. Dyestuff Reptr.* **33**, 52–65 (Jan. 31, 1944).

In order to follow the progress of wool dyeing and to note the change brought about by time and temperature with respect to the position of the dye in the fiber, samples of wool yarn were taken from the dyebath at various periods in the dyeing and by means of photomicrographs the percentage of undyed, ring dyed, light and dark dyed fibers determined. Data obtained in this way, using typical dyes in each of the several classes of wool dyes, is discussed and presented in graph form together with a number of illustrative photomicrographs. It is shown that in wool dyeing there are critical temperatures, varying with the individual dyes, at which changes take place sharply and for level results especial care must be exercised at these points. Leveling properties are probably related to the ease with which diffusion of the dye into the fiber takes place once the dye is on the fiber. Poor leveling dyes continue to build up depth of color with very little equalization of the absorbed dye taking place, some fibers remaining undyed throughout the operation, and redistribution may not be appreciable even after prolonged boiling. The rate of dyeing of chrome dyes by the top chrome method (without afterchrome) is shown to be about six times as fast as by the metachrome method. The effect of the physical and chemical condition of the wool on the rate of dyeing is also considered.

Chlorinated Paraffin

The use of chlorinated paraffin in rendering fabrics resistant to fire, water, and mildew. A. E. Irvine. *Am. Dyestuff Reptr.* **33**, 189–92 (Apr. 24, 1944).

Chlorinated paraffin is a principal ingredient of flameproofing compositions for application to fabric. Its fire-resistant action is believed to be due either to the

evolution of flame-smothering HCL gas or to the formation at the combustion temperature of the cloth of volatile metallic chlorides (by combination with the metallic compounds present in the formulation), which possess flame-suppressing qualities, metallic oxides, particularly those of zinc, iron, and antimony, greatly accelerate the decomposition of chlorinated paraffin at high temperatures. The action of the other ingredients of the more or less standard flameproofing mixture is discussed, and the mixing of these substances and their application to fabric is described. It is pointed out that chlorinated paraffin of higher chlorine content, 68–70 percent as compared with the usual 42 to 45 percent, has recently been made available, but its use results in a stiff fabric. Paraffin of the lower chlorine content acts as a satisfactory plasticizer for the more highly chlorinated variety. Although chlorinated paraffin is itself to some degree a fungicide, some one of the well-known more potent mildew or rot-proofing agents is usually incorporated with the flameproofing composition.

Application of Coatings

Machines and methods for plastic coatings. John B. Cleaveland. *Textile World* **94**, 90–1 (May 1944).

In the second article of a series, the author discusses three types of roll coaters: transfer roll coaters, calendar coaters, and reverse-roll coaters.

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

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Protein Fibers

Artificial fibers from corpuscular and fibrous proteins. Harold P. Lundgren and Richard A. O'Connell. *Ind. Eng. Chem.* **36**, 370–4 (Apr. 1944).

Proteins in general are potential fiber-building material. By proper manipulation of proteins derived from surplus and waste agricultural and industrial commodities, fibers have been made with molecular orientation, strength, and moisture-absorbing characteristics comparable with those of natural protein fibers. These fibers have been made with dispersing agents which are mild in comparison with those commonly used for commercial protein fibers. The agent (a detergent) used not only serves as a solvent for proteins but also interacts in appropriate mixing proportions with proteins to form complexes containing unfolded protein. Solutions containing complexes of appropriate composition can be used to make fibers, either by passage through a spinneret into a coagulating bath of salt solution, or by precipitation with inorganic salt with subsequent drawing of the precipitate into a fiber. The detergent can be recovered with aqueous acetone, leaving the peptide chains in the resulting protein fibers in such a state that they can be oriented by drawing in live steam. Secondary and primary valence cross linkages then occur which hold the peptide chains in a highly oriented condition when the fiber is removed from the steam bath. As the degree of orientation in the fibers is increased, tensile strength and water resistance increase although the range of elastic deformation decreases.

Knitting Yarns

Selecting yarns for knitting. C. W. Bendigo. *Textile World* **94**, 81–8 (Apr. 1944).

Tables are presented which show the range of yarns that can be run on the various machines, the most common yarns run, and other pertinent information such as rayon and cotton twists. The information is given only for general machine types. Both single and ply yarns are shown in the charts which are arranged for the following divisions of the industry: (1) full-fashioned hosiery, (2) seamless hosiery, (3) half-hose, (4) underwear, and (5) outerwear.

Sizing Nylon Knitting Yarns

Sizing problems in the knitting of Nylon. Anon. *Silk and Rayon* **18**, 315–17 (March 1944).

English patent 554,268 describes a size for nylon knitting yarns that consists of a partially saponifyed polyvinyl acetate together with boric acid. It is claimed that nylon yarns sized by the method disclosed knits

well on a full-fashioned hosiery knitting machine and does not stick to the needles or machine guides even when the yarn is knitted wet. The adhesion is said to be excellent. The viscosity of the size is regulated by controlling the pH and percent boric acid.

Woolen Manufacturing

The manufacture of silky wool and the production of scroop. Udo. *Deut. Wollen-Gewerbe* **73**, 581–2 (1941); *Chem. Zentr.* 1941, **II**, 1562 (through *Chem. Abstr.* **37**, 1884[5]).

The goods are treated with dilute HCl, $Ca(OCl)_2$ solution. $NaHSO_4$, and again with HCl and dyed. As chlorinated wool absorbs dyes more rapidly than unchlorinated wool, it is best to start dyeing with easily penetrating dyes without the use of acids; if necessary the acids can be added on exhaustion of the dyeing bath. After dyeing, the goods are rinsed well, centrifuged and either soaped and acidified or only soaped. Data are given on the chlorination of worsted goods by means of machines. In order to produce scroop, the goods, after dyeing, are treated with a cold bath of Marseilles soap, centrifuged carefully, acidified slightly with HCl or H_2SO_4, centrifuged and dyed. A very soft feel is created by means of Marseilles soap, olive oil and dilute NH_4OH. Yarns which are only to be felted and shrunk are treated with dilute HCl and $Ca(OCl)_2$ baths; $NaHSO_4$ treatment may be omitted.

MISCELLANEOUS

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Accident Reduction by Safety Color Code

Safety color code for textile mills. Anon. *Textile World* **94**, 80–1, 146 (May 1944).

A method of identifying exposed hazards about textile mills which will tend to reduce accidents is illustrated and described. This is a uniform system of color signals developed by E. I. du Pont de Nemours & Co. and endorsed by the National Safety Council and is based on sound scientific facts and research. It establishes as suggested standards certain colors to indicate accident hazards, identify protective equipment and assure orderly arrangement and good housekeeping. Six colors have been selected: high visibility yellow, for marking obstructions; alert orange, for injurious hazards; safety green, for safety equipment; precaution blue, for equipment not to be moved or started; and traffic white, gray, or black (depending on the background) for zoning. The use of standard symbols makes the system usable by color blind persons.

Color Aptitude Test

Color aptitude test developed for textiles. Lee Forest Dimmick. *Textile World* **94**, 84–5 (May 1944).

A technique is described for determining an employee's probable success in matching samples. This color-matching test has been devised by a committee of the Inter-Society Color Council which brings out the degree of precision a person uses in discriminating colors and the speed with which he is able to carry on such discriminations.

Electronic Controls

Maintenance of electronic controls. W. D. Cockrell. *Textile World* **94**, 82–3 (May 1944).

Although electronic equipment, generally, requires less maintenance than other electric equipment because it has no moving or wearing parts, it is essential that certain procedures and checks be followed and that troubles be located and remedied as quickly as possible. An engineer of the Electronics Section, General Electric Company, outlines procedures for preventative maintenance, trouble-shooting, and repairs. Reasons for equipment failures are described.

Grade Terminology

The grade terminology problem. Iler J. Fairchild. *U. S. Dept. of Commerce, Miscellaneous Publication* M **173** (Mar. 7, 1944).

This paper sets forth in digest form the grade terms, designations, and bases for grading or rating for 64 commodities and

characteristics selected as broadly representative of the various grading and rating systems used in the United States. These terminologies and designations are compared in the light of the technical background for each commodity and impartially from the viewpoint of the buyer, seller, the inspection or testing agency, enforceability, and provisions for future improvement in a search for underlying principles and postulates as a general guide in the selection, formulation, or revision of grade designations in the future. Five general conclusions are drawn in order that grade terminology for the future may be further coordinated, simplified, and clarified. Textile subjects include cotton; fabrics-colorfastness; fabrics—yarn slippage and thread count; hair; wool and wool top; and asbestos yarn.

Radio Frequency Power

Radio power for processing chemical materials. John W. Robertson. *Ind. Eng. Chem.* **36**, 440–7 (May 1944).

During the past few years there has been a tremendous growth of interest in and experimental work on the uses of radio frequency power for dialectric heating and processing. This paper was prepared to answer many of the questions asked by chemical engineers, and to give to the chemical worker a starting knowledge of this new tool. Fundamentals of the process are discussed. Ways of applying the power to different loads are discussed, and data are presented to show some of the possible selective heating effects. Equipment costs, advantages, and disadvantages of RF power are covered briefly. A partial bibliography of articles and patents is added to assist readers in obtaining further information.

Paint Molds

Influence of zinc oxide on paint molds. S. B. Salvin. *Ind. Eng. Chem.* **36**, 336–40 (Apr. 1944).

Fungal spores were sown on paint vehicle constituents and incubated. Varying degrees of growths were observed, with raw linseed oil providing the most luxurious development. This demonstrates that, for mildew resistance, paint films have to depend upon pigments or other ingredients. The effect of nine types of zinc oxide on the growth of common fungi was studied. The inhibition of fungal growth was found to be a direct function of the surface area of the zinc oxide; a fine-particle-size zinc oxide was particularly effective. Although zinc oxide is able to prevent the growth of mycelium or the germination of spores, it is unable to kill the spores and to prevent their germination after removal from the medium and exposure to a more favorable environment. Therefore, zinc oxide cannot be regarded as possessing fungicidal properties; its action is fungistatic. Respiration studies indicate that the zinc ion affects the carbohydrate metabolism of the fungus and that this property may be basically responsible for the fungistatic effect previously described.

Solubility of Plasticizers

Solubility of certain plasticizers in liquid ammonia. Philip C. Scherer and Edward O. Sternberg. *Rayon Textile Monthly* **25**, 143–5 (Mar. 1944).

The use of liquid ammonia as a solvent for cellulose derivatives was recognized and patents were applied for in 1921. It offers several interesting advantages over the ordinary commercial solvents, because very rapid elimination of solvent from film or filament is possible and the product is obtained in a perfectly anhydrous form. Experiments using liquid ammonia as a solvent for nitrates or acetates soon showed that, in order to produce a flexible film, it would be necessary to introduce a plasticizer. A search of the literature failed to show plasticizers with suitable solubility in liquid ammonia and the present paper is a report of a series of experiments to obtain the required information. Eighteen of the most commonly used plasticizers were tested; the results are tabulated. Triethylene glycol di-(2-ethylbutyrate) (Flexol 3GH) gave the highest solubility figures of all the agents tested; other glycols and two sulfonamides were found to be stable toward the solvent and soluble therein. The glycolates and diphenyl phthalate reacted vigorously with the solvent.

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